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SIMPLIFIED
WEIGHTS & MEASURES

LOWIS D'A JACKSON A. I. C. E.

SIMPLIFIED WEIGHTS AND MEASURES,

ON

A NATURAL SYSTEM APPLICABLE TO MOST CIVILIZED NATIONS.

BY

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SIMPLIFIED WEIGHTS AND MEASURES.

1. The Defects of the present Systems, and the necessity for their Simplification.

There can be at present few, if any, Englishmen that have so thoroughly mastered the whole collection of British weights and measures as to be able to answer correctly from memory all questions that may be put to them on the subject. A complete collection of tables, some suited to the purposes of one branch of trade, some to another, would, if classified, as they should be, into four distinct categories, those of length, surface, capacity, and weight, be found to show an extraordinary complication. The four categories themselves would also possess little or no mutual dependence of a systematic character; being totally destitute of the advantages of the French metrical system, although doubtless having in some respects a great superiority over it. Apart from their want of regularity or uniformity, some names of measures are used for two or more very different quantities, as for instance, the troy pound and the avoirdupois pound, the nautical or geographical mile, and the statute mile, the stone of meat and of living weight, as well as others. Beyond this again, some of the names given show evident traces of an absurd deviation from original intention, as a hundredweight, which is now not a hundred, but a hundred and twelve pounds; while again a thousand slates consists of twelve hundred.

In fact, the various and conflicting measures would almost appear to be designed to deceive and defraud those unacquainted with them, which in the first place constitute the great majority of the British public, and in the second place all foreigners also.

This is highly discreditable to the English nation; more, it is foolish. Why should we deceive ourselves, that is to say each other? If the trader in liquids may now gain by deceiving his customers in his own branch of business, yet when it comes to carats in jewellery, to bushels of different sorts of agricultural produce, he may be deceived in return; fraud begets fraud, and the perpetrator of it robs himself of a quality more precious than anything he may steal from others. How shortsighted then is such a policy!

The extension of knowledge is one of the most crying wants of the age; to further this, it is even proposed to alter the mode of spelling of a great number of words in the English language, which are extraordinarily incongruous; surely then it would be also advisable to systematize the weights and measures, and thus put them within the comprehension of the masses.

In fact a change, a modification, though not of a radical nature, is absolutely necessary. There are, however, large numbers of people that are opposed to any change whatever; some from simple obstructiveness, some from sheer laziness, and unwillingness to use their minds for purposes of reflection or thought of any sort; some from stupidity and the mistaken belief that they themselves would suffer in some way; others, the more sensible, from a belief that the best system and that most suited to the wants of the public has not yet been brought forward.

One of the principal pleas urged against any change whatever by the class of simple obstructives is based on an entirely mistaken idea; it is that the masses would find any

change a most serious grievance, and that they are wanting in the capability of adapting themselves to it. This might be the case in the adoption of a very sweeping change of system, as that of the French metrical system, but would not be so in a moderate modification; if the new yard, only one per cent. longer than the existing one, were adopted, the public generally, including the most ignorant, would not be slow to learn that the new yard was only about one-third of an inch longer than the old one; in the same way too with any measure of weight or capacity; they would not require any tables of conversion for habitual use, these being only necessary for tradesmen on a large scale, who must have sufficient knowledge, from the extensiveness of their business, to be able to apply such corrections or alterations with very little thought or care.

The lazy, unreflecting class require no reply, as it would give them too much trouble to think about the matter; they will of course have eventually to follow their betters, who can both think and act.

The stupid class, afraid of losing personally by any change, can only be told and eventually persuaded that any gain to the whole community must necessarily be also a gain, and not a loss, to themselves; that their convenience is that of the public also, and that they will pay proportionate prices according to whatever measure or weight may be adopted, an arrangement under which no one suffers in purse.

Last, the sensible class, who require the best system possible, and are determined to wait till they get it.

To these one would say, consider and determine frankly whether you are perfectly satisfied that a modification of our mass of incongruous English measures is really advisable; if you are assured of this, examine carefully the various systems that have been proposed, and say which is in your opinion the best or that most suited to the wants

of the community at large, and what further improvement it requires; or propose a better system yourself than any of these. If you will not do this, you degenerate into a temporising obstructive, and cease to have any claim to be considered a sensible man with reference to the matter under investigation.

There is, however, in addition to these classes, a large number of well-informed men that would be glad to countenance and adopt any good rational modification of our present systems not productive of serious inconvenience, although fully aware that a certain amount of inconvenience must accompany the adoption of anything new; they, however, see the hosts of probable opposers, and retire from the field with faint hearts. To such, one would say, "Let your voices and arguments be heard on the side of reason, justice, and common sense. A simplification of our systems of weights and measures is advisable; let it not be deferred till the dim future, for other generations to look back on us with pity."

2. The Defects and Advantages of the French Metrical System.

The French metrical system is the most radical change and the most unpractical system of weights and measures that has perhaps ever been invented, and required the most theoretical, sentimental, and most revolutionary of nations to adopt it. Even with them it can hardly be said to be a complete success, though favoured by every possible conjunction of circumstances. The Latin races, who alone have fairly and fully followed the French in attempting to adopt the metrical system in its entirety, and to the exclusion of their own older methods, have had but a partial success in so doing. The Italians, the Spaniards, Portuguese, and Belgians cannot refrain from using their own measures as

well. The Dutch have perhaps been more successful, from the fact of retaining the names of their old measures while giving them to the new metrical ones. Republican Switzerland, even, if we except the Canton de Vaud, has failed in adopting them even to a moderate extent. The practical Teutonic races generally, German, English, and Scandinavians, and even the Russians, fond of autocratic systematization as they are, have virtually rejected the metrical system, by simply permitting it under a scientific pressure, now surely and steadily diminishing.

It is at present a species of *lingua franca* among scientific men, as the French language was at one time under pressure the language of diplomatists, a common meeting-ground for those who are indifferent generally as to the units they adopt; and this is perhaps the only object that it effectually serves; for the peoples, the masses, it is a temporary illusion and a delusion, although an attractive one.

Let us examine this pleasing snare. A rather long yard of 3·2809 feet is taken as the unit and basis of the system, and is fixed in a decimal proportion to the mean radius of the earth, a quantity by no means perfectly finally determined; it is not the length of a seconds pendulum at Paris. It is multiplied and subdivided decimally, giving a series of nicely arranged names of length, the greater part of which are rather names than measures, and not suited to any practical purpose, but rather forced against practical requirements. Who requires the decimètre of length, or the decamètre, hectomètre, or myriamètre? The centimètre is nowhere near the inch of any civilized nation, and the kilomètre is only in one very exceptional case the Russian verst, near their miles. On proceeding to metrical measures of surface, the hectare is that designed to take the place of the acre, or ploughman's day's work of most nations, This, again, is nowhere near the acre of any other

nation, if we omit the very exceptional case of the Russian dessatina. The are, deciare, and centiare are again mere names, and do not fairly take the places of measures. In measures of capacity they have the cubic mètre as a cubic yard, a litre to take the place of the various gallons, and a hectolitre to take that of the various bushels of civilized countries, while they signally fail in so doing, as a cursory glance at a list of foreign measures will show. The litre, however, serves an excellent purpose in wine-growing and wine-drinking countries. It is an excellent measure for a bottle of wine or spirits, and corresponds to the practical want shown by our adoption of our imperial quart for malt liquors.

Continuing to measures of weight, the gramme is too large for the delicate purposes for which we employ grains; the kilogramme is about double the pound of any other nation; the quintal holds the same relation to the hundredweights of other countries, if we except the Russian, semi-oriental, berkowitz; finally, the French tonneau corresponds well with the tons of such nations as have them as weights, in the same way that at the starting point the mètre was an approximate yard, while nowhere between these extremes has the metrical system shown itself adapted to the practical requirements of the masses, the substitutes offered for the old measures being singularly inadequate, and the greater proportion of the so-called measures being mere names.

The centigrade division of the thermometer, while much to be recommended from the position of its zero at freezing point, is otherwise inconvenient, its degrees are too large for ordinary purposes, and their tenths too small. The fall of one degree Fahrenheit during severe tropical heat is a quantity affording a luxurious and instantly felt relief; the same amount is also appreciable to our senses in the cooling of an overheated room in England, while the French degree is too coarse to estimate such a quantity.

The attempt to decimalize the right angle by dividing it into 100 grades instead of 90 degrees resulting in a signal failure, may be considered as the *reductio ad absurdum* of the system; although there was perhaps a still more foolish attempt to make new weeks of ten days instead of seven, and this which we may consider the keystone of the system, hence calls for special notice.

We are all aware that there is nothing that is really sacred now in any special number, nor in any institution borrowed from the ancient Jews; the glorious founder of true religion, and his apostle to the non-Jewish races, delivered the world from all such intolerable burdens. Besides, we are convinced that if it is a religious action to attend public worship once in seven days, that must then be far less religious than it would be to attend twice or three times in seven days. But the present natural requirements of communities are to a very great extent based on the habits of ages, and the day of respite from labour, or rather the day and a half in England, occurring once in seven days, is one of these. Ignoring this practical requirement, and attempting to make the week consist of ten days, seems the height of folly. It is this self-same principle that runs through nearly the whole of the revolutionary metrical system, and constitutes its inherent vice; the feet, miles, acres, gallons, bushels, grains, pounds, and hundredweights of all civilized nations, which are all similarly based on practical requirements, are ignored in the same way.

Let us now notice the good points and advantages that the metrical system undoubtedly possesses; they are: 1st, its uniformity; 2nd, its simplicity, which is dependent entirely on its being a decimal system; 3rd, the mode in which the measures of surface, capacity, and weight are made dependent on those of length, or the mutual interdependence of the whole of its weights and measures.

Of its systematic regularity and uniformity too much praise cannot be given. This appears, however, as before shown, to have been purchased at too high a price; too much has been swept away to make room for it. Its simplicity is almost entirely the result of its being a rigid decimal system, and this must be noticed apart from its being a metrical system; its decimal advantages could easily be applied to any arbitrary unit; anyone may take a yard, a foot, or a mile of any nation, multiply and subdivide it decimally and complete a rigid system of decimal measures of length, surface, and capacity; these would then probably have quite as many advantages as the French metrical system, which only comes in practically well at the litre and the tonneau or tonne. As for names, there is very little difficulty in manufacturing or borrowing them. The measures, however, would not be practically useful in any system developed in this blind method; although they would possess the advantages of a decimal system.

The mutual interdependence of the metrical system is, however, its greatest advantage. Having a rod one mètre in length, any individual may obtain or construct for himself at least approximately any other measure or weight in the whole system. In the first place, he can easily multiply and subdivide the mètre decimally, thus obtaining any measure of length; secondly, to obtain a measure of surface, he measures a distance of 100 mètres, and another such distance at right angles to it, obtaining the hectare; thirdly, measuring a mètre in three directions he obtains a cubic mètre, of which the litre is the thousandth part; and lastly, by means of distilled water he obtains the unit of weight, the kilogramme, which is equal to a cubic decimètre of water. He probably might not do this very accurately, but he certainly could do it sufficiently approximately to answer ordinary purposes.

From the foregoing examination, we may conclude that

the French metrical system is, from its inherent defects, utterly unsuited to the practical wants of any practical nation; but that its advantages should, if possible, be obtained in any new system of weights and measures designed to supplant the heterogeneous collections used by the English, German, and Teutonic races generally.

3. The Inadvisability of any Sweeping Change based on a New Notation.

It has been long imagined by a certain small number of the more highly educated that a very sweeping alteration of our weights and measures might be devised, which, based on some entirely new system of notation, might entirely supersede the necessity of any decimal system whatever, and leaping over the French metrical system, would possess highly preponderating advantages. These gentlemen argue very justly that the number 10 is a very inferior one in itself. It happens to be the first number represented by two digits, and this is probably due to the fact that semi-barbarous people require the aid of their fingers for counting up to ten, but there is no necessity whatever that this should always remain the case; it would require but little inventive power to devise forms of single digits up to sixty or sixty-four in number. It would not, moreover, require very much additional labour to learn them, as one quarter of their forms might be inverted and reversed to make up the remaining three quarters, and thus made to aid in retaining their values on the memory: besides this mode there are many other ways of getting over this difficulty; they might be so devised as to render the learning by heart of the multiplication and division table almost needless, or so easy as to be a small instead of a serious labour for children. So far this is all perfectly true as well as practicable.

The number ten is doubtless a very inferior one, it is divisible by 2 and 5, but cannot be divided either by 3 or 4 without going into fractions; its square root and cube root are improper fractions. The number twelve is superior to it, being divisible by four factors, 2, 3, 4, and 6, but its useful roots are equally unfortunate. The number sixteen, which is divisible by three factors, 2, 4, and 8, is also superior to the number ten in this respect; while some of its roots are integral numbers, its square root being 4, its fourth root 2, and its cube root being nearly $2\frac{1}{2}$. The number sixty-four, admitting of perpetual halving down to unity, and having the convenient numbers 8 and 4 as square root and cube root, is again superior to sixteen. The number sixty, whose useful roots are improper fractions, is inferior in this respect, but is advantageous in having as factors for subdivision, 2, 3, 4, 5, 6, and 10; it is hence one of the most valuable of numbers, and has been adopted for ages, certainly since the time of the Assyrians, who were very fond of this number, for the subdivision of hours and minutes, and its multiple 360 for the subdivision of the circle.

If either of the exceedingly useful numbers, sixty or sixty-four, were adopted as the basis for a new notation, we should merely require six or seven new forms for single digital numbers, the remainder being formed by inverting, reversing, and inverting and reversing them.

Beyond this again, if a new notation were required that would enable the logarithmic calculations of scientific men to be rapidly made without the use of tables of logarithms, an altogether new mode would be necessary, in which the Napierian base would play an important part. Other systems, like that of Oliver Byrne, in which the ascending and descending notations are different, might also be devised to save labour in calculation.

But to any and all of such proposed alterations of notation,

however useful they might be to the highly educated, there is the insuperable objection that there is not the slightest probability of their being adopted by the masses for another century to come.

Let us assume that some really clever scientific man has discovered some new mathematical law, series, or notation, by means of which the operations of multiplication and division, and of finding roots, powers, and functions of numbers are reduced to a minimum of labour nearly independent of extraneous aid in the form of lengthy tables. Such a thing would be an invaluable boon, deserving of the gratitude of ages to come, as well as of the present generation. But its advantages would be firstly gained by the scientific, and through them would arrive at the general public. It would be a hopeless task to induce the ordinary public to make use of it. Not that the ignorant masses are incapable of learning such things, far from it! The masses in England have a strong mathematical tendency and aptitude, undeveloped though it be; the children in the schools could be comparatively easily taught that, or anything of that sort by competent instructors. The difficulty would lie with the large masses of semi-educated, and with the partially educated, including a large number of learned men having undoubted talent in certain branches of science, but deplorably ignorant as to others. The masses of semi-educated have been taught to a sticking point, beyond which it appears very difficult to urge them; they have mostly learnt at school or college, besides the three celebrated R's, and a certain amount of book-history and geography, a fair amount of Latin, a smaller amount of Greek, some bad French, a smaller amount of algebra and of ponderous Euclid, without obtaining any facility in its use or application; if in addition to this they have heard a few lectures on chemistry, of the interesting flash-and-pop school, on electricity and other branches of

physics, their education is in their own eyes perfectly complete. These are the men that are the barriers to all further progress, the unreasoning obstructives of every proposed change of the nature before mentioned. Have they not learnt everything? Changes and progress would either require from them the fresh exertion to learn more or would leave them in the background; they therefore settle down to the immovability that is certain to let bad alone. Men of this class are so numerous in this country that any sweeping and comprehensive change of notation intended for general use would be rendered utterly impracticable, even if there were a large number of influential and educated men assured of the advisability of such a proceeding.

4. The Objects to be kept in view in simplifying or Remodelling our Systems of Weights and Measures.

In simplifying and systematizing the weights and measures of any country, certain objects have to be kept in view in order to do it to the best advantage; it is therefore necessary to enumerate and explain these objects before proceeding further.

1st. The greater part of the existing weights and measures should be modified and altered as little as circumstances will allow, or as the systematization will admit. That is to say, that while some unnecessary measures may be abolished, and some altered in value, the mass of the more useful measures must not be swept away, while the greater part of them must not be altered in value to any very great extent.

2nd. The systematization of the measures (we call them thus, as when we say weights we really mean measures of weight, and not actual weights) must necessarily be made suitable to the decimal notation of every-day life, wherever

it can be made convenient to make it so; and where this is not the case, the ratios of the existing measures must be retained.

3rd. All measures of length, breadth, height, depth, thickness, and distance, in whatever trade or occupation, or for whatever purpose they may be employed, must in the new system be entirely comprised in one set of measures of length; a corresponding condensation and arrangement must similarly be effected for all measures of surface; in the same way too for all measures of capacity, whether for dry goods or liquids of all sorts; and similarly for all measures of weight, whether living or dead, whether of agricultural, manufactured, or mineral produce, whether drugs or precious metals.

4th. The interdependence of the measures of length, surface, capacity, and weight, must be carefully worked out, in order to form one complete system.

5th. The relation between measures of capacity and measures of weight will be best preserved by adopting the universally recognized principle of comparison by means of distilled water at a certain temperature and atmospheric pressure.

6th. The existing names of measures should be retained generally, and no new names introduced whatever, if they can be possibly avoided.

Having previously agreed that a systematization is desirable, and now assuming that these six objects contain the most important principles to be kept in view in devising the mode of carrying it out, we cannot go far wrong in making an attempt to develop a system which will answer our purposes. We have a certain amount of raw material, or existing measures and certain principles to guide us in their rearrangement and simplification. The best system will then be that most in accordance with our principles, and will

only be arrived at by a tentative process, after rejecting the inferior systems in favour of the most perfect one that the principles admit. The system hereafter described has been thus arrived at, after an examination and careful consideration of the weights and measures of all nations.

5. The principal Weights and Measures of all Nations.

The examination of the following five pages of tables, which give the values of the principal measures of length, surface, capacity, and weight of the more important nations of the world, leads inevitably to certain unmistakable inferences, which serve as a guide in deducing a rational system that will be more or less applicable to all these countries. The natural development of these existing measures will aid us in more thoroughly comprehending them.

In primitive times there were generally no measures of surface or of capacity, as we now have them, but only measures of length and of weight; the measures of length corresponding to the side of a square surface rendering superficial measures quite unnecessary, and measures of weight being used instead of measures of capacity in almost all trade transactions; of this there is ample evidence in the ancient Jewish sacred books, and in the customs of Oriental races to the present day.

The measures of length were the finger-breadth, the palm-breadth, the foot-length, the cubit, the pace, the pair of paces, the hundred cubits, or acre-side as we would now term it, the thousand pair of paces or mile, and the day's journey, a very variable distance. The measures of weight were the weights of the principal coins in ordinary use, stones of various sizes bearing certain proportions to the weight of a certain number of these coins, and the weight of

EQUIVALENTS OF FOREIGN MEASURES.

By Comparison with the Metrical Standards of 1872.

(From Jackson's Hydraulic Manual.)

The Feet of various Nations.

		Linear.		Square.		Cubic.	
		English Linear Feet.	Mètres.	English Square Feet.	Square Decimètres.	English Cubic Feet.	Cubic Decimètres or Litres.
1	English, American, and Russian foot	1·	0·3047	1·	9·2846	1·	28·2909
2	The mètre of France, Italy, Spain, and Portugal	3·2818	1·	10·7704	100·	35·3467	1000·
3	Rhein-fuss of Prussia, Denmark, and Norway..	1·0299	0·3138	1·0609	9·8504	1·0928	30·9158
4	Austro-Hungarian and Bohemian Imperial foot	1·0375	0·3161	1·0762	9·9921	1·1164	31·5852
5	Swedish foot	0·9744	0·2969	0·9492	8·8130	0·9248	26·1629
6	Hanoverian foot	0·9586	0·2921	0·9189	8·5319	0·8809	24·9214
7	Bavarian foot	0·9580	0·2919	0·9174	8·5182	0·8788	24·8611
8	Wurtemberg foot	0·9402	0·2865	0·8840	8·2077	0·8311	23·5142
9	Baden foot, and Swiss (Vaud)	0·9846	0·3000	0·9693	9·0000	0·9544	27·0000
10	Portuguese foot	1·0830	0·3300	1·1729	10·8900	1·2702	35·9370
11	Spanish foot (Burgos)	0·9133	0·2783	0·8343	7·7469	0·7622	21·5623
12	Arabian foot	1·0502	0·3200	1·1029	10·2400	1·1582	32·7680

Equivalents of Foreign Measures of Length.

Miles.	In Local Measures.	Number in a degree of latitude.	English Statute Miles.	Kilomètres.
The geographical mile of England and America, and nautical mile of all nations	6076·98 ft.	60·	1·1509	1·8516
English statute mile since 1824 ..	5280 ft.	69·06	1·	1·6089
Old English mile, now used on Indian canals	5000 ft.	72·93	0·9470	1·5236
Irish mile	6720 ft.	54·26	1·2728	2·0477
Scotch mile	5952 ft.	61·26	1·1273	1·8137
Kilomètre of France, Italy, Spain, and Portugal	1000 m.	111·10	0·6216	1·
Prussian and Danish post mile ..	24000 ft.	14·75	4·6816	7·5322
Austrian mile	24000 ft.	14·65	4·7136	7·5836
Russian verst	3500 ft.	104·18	0·6629	1·0664
Hungarian mile		13·33	5·1806	8·3350
Norwegian mile		10·	6·9055	11·1100
Swedish mile	36000 ft.	10·4	6·6395	10·6827
Belgian, Dutch, and Polish mile ..		20·	3·4527	5·5550
Wurtemberg geographical mile ..	26000 ft.	15·	4·6036	7·4067
Baden stunden	14815 ft.	25·	2·7622	4·4440
Bavarian mile of Anspach	28800 ft.	12·87	5·3666	8·6342
Swiss league	18000 ft.	20·58	3·3564	5·4000
Italian miglio		60·	1·1509	1·8516
Greek stadium (modern)		112·16	0·6156	0·9905
Arabian and Egyptian mile	6000 ft.	57·88	1·1933	1·9200
Portuguese milha	6236 ft.	54·	1·2788	2·0574
Spanish milla (Burgos)	5000 ft.	79·86	0·8650	1·3917
Turkish berri		66·66	1·0361	1·6670
Chinese li	360 paces.	199·72	0·3458	0·5563
Japanese ri	4 li.	49·93	1·3831	2·2253

Equivalents of Foreign Measures of Surface.

Acres.	In Local Measures.	English Acres.	French Hectares.	Acre-side in English Feet.
English and American acre	43 560 sq. ft.	1·	0·404 44	208·7
Irish acre	70 560 sq. ft.	1·6199	0·655 11	265·6
Scotch acre	55 353 sq. ft.	1·2708	0·513 92	235·3
French hectare	10 000 sq. m.	2·4725	1·	328·2
Russian dessatina	2 400 sq.sash	2·4954	1·092 50	343·0
Prussian morgen	25 920 sq. ft.	0·6313	0·255 32	165·7
Wurtemberg morgen	38 400 sq. ft.	0·7793	0·315 17	184·1
Baden morgen	40 000 sq. ft.	0·8901	0·360 00	196·9
Amsterdam morgen	101 400 sq. ft.	2·0095	0·812 71	295·7
Polish morgow	67 500 sq. ft.	1·3843	0·559 87	245·4
Hanoverian morgen	30 720 sq. ft.	0·6476	0·261 92	167·7
Austrian jochart	57 600 sq. ft.	1·4230	0·575 54	249·0
Tyrolese jauchart	36 000 sq. ft.	0·8900	0·359 94	196·5
Swiss (Vaud) juchart	50 000 sq. ft.	1·1126	0·450 00	220·1
Norman journal	77 440 sq. ft.	2·0204	0·817 15	296·7
Bavarian tagwerk	40 000 sq. ft.	0·8425	0·340 73	191·6
Swedish tunnland	56 000 sq. ft.	1·2203	0·493 53	230·6
Danish toende-hartkorn ..	224 000 sq. ft.	5·4557	2·206 49	487·3
Piedmontese giornata	14 400 sq. ft.	0·9398	0·380 09	202·1
Venetian migliajo	25 000 sq. ft.	0·7474	0·302 30	180·1
Tuscan saccata	16 500 sq. br.	1·3895	0·561 97	245·7
Roman pezza	52 900 sq. pal.	0·6529	0·264 07	168·6
Arabian feddan	57 600 sq. ft.	1·4584	0·589 82	251·9
Portuguese geira	4 840 sq. va.	1·4480	0·585 64	251·3
Spanish cuadra cuadrada ..	22 500 sq. va.	3·9600	1·603 56	415·3
Spanish fanegada	82 944 sq. ft.	1·5888	0·642 56	262·8

Equivalents of Foreign Measures of Capacity.

Wet and Dry Measures.	Gallons.	Litres.	Side of Cube in English Feet.
English Imperial gallon of 10 lbs. water, 277·274 cub. inches ..	1·	4·54	0·543
Old English wine gallon (American) 231 cub. inches ..	0·833	3·78	0·511
Old English beer gallon, 282 cub. inches	1·017	4·62	0·549
French litre, 1 cub. decimètre ..	·220	1·	0·328
Russian vedro	2·708	12·30	0·756
Prussian anker, $\frac{4}{5}$ of a scheffel ..	7·564	34·35	1·065
Danish anker	8·242	37·43	1·096
Swedish anker	8·641	39·24	1·114
Dutch anker	8·387	38·09	1·102
Austrian eimer	12·774	58·01	1·263
Bavarian eimer	15·066	68·42	1·340
Wurtemberg eimer	64·721	293·93	2·189
Swiss (Vaud) eimer	8·918	40·50	1·125
Turkish alma	1·154	5·24	0·569
Portuguese almude (Lisbon) ..	3·642	16·54	0·835
Spanish arroba (Castille)	3·554	16·14	0·828
	Bushels.	**Litres.**	**Side of Cube in English Feet.**
English Imperial bushel, 8 gallons	1·	36·33	1·087
Winchester bushel (American) ..	0·969	35·22	1·074
French hectolitre	2·7522	100·	1·523
Russian tschetvert	5·772	209·73	1·948
Prussian scheffel	1·512	54·96	1·246
Danish skieppe	0·478	17·39	0·849
Bavarian scheffel	6·119	222·35	1·986
Wurtemberg scheffel	4·878	177·23	1·842
Dutch schepel	0·275	10·	0·707
Austrian metze	1·693	61·49	1·293
Swedish spann	1·962	73·25	1·371
Portuguese fanga (Lisbon) ..	1·488	54·08	1·239
Spanish fanega (Castille)	1·572	57·15	1·262

Equivalents of Foreign Measures of Weight.

Pounds and Tons.	Equivalent in Distilled Water according to Local Measure.	English Grains.	French Grammes.
English pound avoirdupois .. nearly	$\frac{1}{62}$ of a cub. ft.	7000	453·6
English pound troy .. .. nearly	$\frac{1}{76}$ of a cub. ft.	5760	373·2
Old English and Scotch pound nearly	$\frac{1}{58}$ of a cub. ft.	7600	492·3
French kilogramme .. .. exactly	1 cub. decim.	15432	1000·
Prussian and Wurtemberg pound ..	$\frac{1}{68}$ of a cub. ft.	7217	467·7
Danish and Norwegian pound	$\frac{1}{63}$ of a cub. ft.	7707	499·4
Swiss (Vaud) pound	$\frac{1}{64}$ of a cub. ft.	7716	500·
Austrian and Bavarian pound		8642	560·
Russian pound		6317	409·4
Swedish skālpund		6535	423·5
Portuguese arratel		7083	459·
Spanish libra (Castille)		7099	460·
	In Local lbs.	English lbs.	Kilo-grammes.
English and American hundredweight	112	112	50·80
French quintal	100 kilog.	220·46	100·
Zollverein centner	100	110·23	50·
Prussian centner	110	113·43	51·45
Austrian centner	100	123·46	56·
Russian berkowitz	400	361·01	163·76
Danish centner	100	110·10	49·94
Swedish centner	120	112·05	50·82
Portuguese quintal	128	129·53	58·75
Spanish quintal (Castille)	100	101·42	46·00
English and American ton	2240	2240·	1016·05
French tonneau	1000 kilog.	2204·6	1000·
German ton (Hamburg)	2000	2135·8	968·80
Russian ton	2400	2166·0	982·53
Portuguese ton	1728	1748·5	793·15
Spanish tonelada	2000	2028·2	920·05

a man, also rather variable. When greater fixity and accuracy became necessary, these personal measures were first taken from the chief or king, and afterwards reduced to fixed standards introduced into the temples and public buildings, and thus accessible to all at any time. A certain amount of uniformity was practically maintained among various races by conquest, which enforced the coinage of the conquerors, and hence also their measures of weight, and probably partly also those of length, on the conquered races. The natural requirements of those ages were thus fully met and maintained. The requirements of the present age are the results of the habits of the past, back to dim obscurity, and appear not to differ from them materially, a comparatively small number of additions, consisting almost entirely of measures of capacity, being engrafted on the system of the past. The consequence is that on examining the measures of various nations at the present day, we find that although they vary in value, yet generally there is still a very strong uniformity of principle, and an approximate uniformity of measure to be noticed, the more noticeable as the want of absolute uniformity in most instances is so clearly due to accidental fluctuation in value of standards, and not to intentional alteration. While drawing attention to this point, we must of course entirely except the theoretical measures of the French metrical system, in which there are only two natural measures, the mètre and the tonneau, and partly except also the Russian measures, which appear particularly heterogeneous, being apparently compounded of those of various races—Oriental, Greek, Tatar, Teutonic, and Sclavonic, and hence affording but few indications of a natural development accruing out of an intended universal fixity.

The primitive measures have been mostly retained in use for centuries until the present day; they have answered

most of our practical wants, and should certainly not be abolished in the mass; they simply require systematizing, correcting, and simplifying in accordance both with the original intentions with which they were designed, and the growing requirements of the present. On examining the changes they have already undergone, it appears that the finger-breadth has developed into the inch, the palm-breadth into the hand of horse-measurement, the foot is retained, the cubit abolished, the pace into the yard and ell, the acre-side seems to have been almost lost sight of after the acre became current, the thousand pair of paces and all similar measures into miles, the day's journey has been subdivided into the Teutonic stunden, or hour's journey, a mile of another description. The various ancient measures of weight, based on certain numbers of well-known coins, have developed themselves into fixed weights now almost entirely independent of coinage, of which the pounds of all nations are the most important; these, like the various feet, vary within very moderate limits. The subdivision of the pound into ounces, drachms, and grains, is effected in a more variable manner. The multiples of the pound are the hundredweight or hundred pounds, afterwards increased; and the ton, which, being a very large measure of weight, is mostly confined to nations having or having had a considerable maritime and commercial importance, and bears traces of its universal origin, a fixed multiple of the hundredweight. The stone still exists with a variety of values, as might well be expected, which have to be explained by the corresponding number of pounds. The king's weight, or the weight of a man, has naturally, consequent on the adoption of other more fixed measures of weight, been entirely abolished in all countries for a very long time, if we except some curious customs of African potentates, and one still kept up by some orthodox Indian rajahs, who are

annually, on a certain high religious festival, put into the scale against an amount of gold, silver, and muslin, which is afterwards distributed among the Brahmins; a habit much approved of and religiously inculcated by those wily ecclesiastics, that apparently corresponds to the payment of church tithes in England, but also possesses a quaintness of its own.

Proceeding to the more modern additions to the ancient system of measures, we may notice as most important the nautical and geographical mile or knot, fixed at one-sixtieth of a degree of latitude, and common to almost all nations, and the nautical fathom of two yards. A temporary purpose has also been served by the adoption of a Gunter's chain of 100 links in measuring land; the square chain being one-tenth of an acre. This expedient has been rendered advisable owing to the moderns having lost sight of the acre-side of ancient times, which evidently must have been at one time 100 cubits, and afterwards perhaps 200 feet; a recurrence to original principles will render this modern innovation totally unnecessary. The more extensive use of iron in modern times, as well as other causes, have led to several modes of subdividing the inch and the foot; various trades habitually using sixteenths, eighths, twelfths, or tenths of an inch; tenths and hundredths of a foot are also found convenient for some purposes, and hence extensively used. A remarkable very modern addition of this nature is the Birmingham wire gauge, giving increasing numbers from 1 to 36 for various thicknesses, from 0·31 of an inch down to 0·004.

As to modern measures of weight, the various pounds adopted in the same country for various purposes, and their various modes of subdivision, as in England the troy weight, the apothecaries' weight, and the avoirdupois weight, and similar arrangements in Sweden and other countries, are a disgrace to any civilized community; these are compara-

tively modern creations, and require, more than anything else in measures, a thorough systematization and reform. In ancient times, when the current coins of the country were used as smaller weights, as they still are in India, there was a far easier comprehension of such matters for the principal persons interested, i. e. the public; but in former times the public represented by the king legislated for the tradesman; at present the tradesman in parliament and on the juries both legislates for and enforces the execution of the laws on the public.

Measures of surface and of capacity are, as before mentioned, comparatively modern, or at least not possessing much fixity before the time of the Romans. Amongst the former there is practically only one of any importance, the acre, of which the rood and the perch are mere subdivisions. The acres of all nations, excluding the French and Russian, and the Danish toende-hartkorn, based on another principle, show a very striking general uniformity. The greater portion of these acres, morgen, tagwerk, and jocharts, are supposed to have been based on the assumption of their being the amount that a man with a pair of oxen could plough in a day; in the same way that the old hide of land, of which there is mention even in the writings of the ancient Greeks, was the amount that the strips cut from a single hide could enclose. Such acres and hides in various soils and from various oxen must, however, have been very variable quantities, so much so as to render impossible that all the acres of various nations of the present day can have been entirely based on that principle; besides, they bear such evident traces of being formed on an acre-side of either 100 cubits or 200 feet, that we may consider the former principle as a secondary one taken in connection with the latter, or perhaps engrafted on to it. The toende-hartkorn, or amount of land that can be sown with a ton of hard corn, is quite exceptional,

and not worthy of imitation in principle. The larger measures of surface are square miles, dependent on the various local measures of length in miles, and hence not worthy of any special remark, excepting that those based on miles that bear some simple ratio to a degree of latitude are by far the most convenient, and worthy of adoption.

Most of the measures of capacity, excluding the cubic inch, cubic foot, and cubic yard, are comparatively modern. Some of them seem to have been based on the Roman congius; they have unfortunately been generally different for liquids and solids or dry goods, some of the former having been based on various arbitrary quantities, skinsful, earthenware vessels, and casks; the latter also on earthenware vessels, cubical and cylindrical boxes, sometimes heaped and sometimes not. As may be naturally expected, the various gallons, ankers, and eimers show a greater uniformity than the dry measures; the former indicating that most of them were originally approximations to cubes, having their sides equal to one foot of local or of foreign value, liquids and wines having been always frequent articles of import; and that the errors introduced by even slightly incorrect measurement of the side of the cubical vessel, sometimes and even very often increased by measurement on the outside of a vessel of variable thickness, may have led to the great variety in cubical content. The list of gallon-sides given in the table helps to explain this. The larger measures of liquids seem to be perfectly arbitrary, depending originally more on the habits of the coopers of various places than on anything else. The measures of dry goods, bushels, scheffels, and metze are so variable, that the search for any original intended uniformity among them seems perfectly hopeless; the larger measures are multiples of these, up to the various tons of capacity, and exhibit the same wide variation.

In fact, the examination of all these modern measures of capacity leads one to consider them to be of so arbitrary an origin, and so diverse in value, that the gallons, ankers, and eimers alone admit of being conveniently systematized, brought back to their original value, and made to serve as a unit of departure for subdivision and multiplication for one uniform series of measures of capacity both wet and dry.

While examining this subject, it may be noticed that the English alone of all nations seem to have made an entirely false step in the adoption of the Imperial gallon. The corresponding measures of most nations are based on cubical measurement, that is to say, they are made to consist of a certain number of cubic inches, or approximate cubic feet, as they rightly should be; the English, in changing from their old wine gallon, which was very nearly a cube, having a side of half a foot, being 231 cubic inches, did not make it a cube having a side of exactly half a cubic foot, or 216 cubic inches, but fixed it by comparison with distilled water, making it 10 pounds, a fatal error in principle. Had they made the pound a tenth of a corrected gallon of distilled water, and arranged the whole series of their incongruous measures of weight in accordance with this new pound, according to the mode so judiciously adopted by the French, they would, on the contrary, have been going on the right course. This will probably explain to many how prudent the United States have been in adhering to the old English wine gallon up to the present time.

On the other hand, however anomalous our gallon may be as a measure of capacity, our pint is a correct, or at least a very nearly correct measure, as it consists of 0·020842 cubic foot, or very nearly 0·02 cubic foot, or the fiftieth part of a cubic foot; a very great advantage, as it thus forms a nearly correct point of departure for a decimal system of measures of capacity.

The foregoing examination of the principal weights and measures of civilized nations will also, it is hoped, have shown how far and in what respect they have strayed from an original and natural uniform system, and in what cases they have set up for themselves independent and arbitrary measures that are not worth further preservation. It may also have thrown a light on the advantages and defects of our English system, with a view of determining the best mode of eliminating the latter.

6. A Rational System of Simplifying British Weights and Measures.

Assuming then both the expediency of a simplification of the entire system of British weights and measures, and the advisability of the principles already established, it may yet be done in several ways.

The mode that would first naturally suggest itself would perhaps be to choose one of our measures of length, one of surface, one of capacity, and one of weight, that bear some definite relation to each other, the measure of weight being compared with that of capacity by means of distilled water at its greatest density; these four measures would then form points of departure for the construction of a regular and complete system. Such a mode, while preserving exact points of departure, fails utterly in the principal of our objects, that of adhering closely to the most of the measures we already have that both have followed a natural law of development and are based on practical requirements.

The following method, while rarely hitting off any of our old measures with accuracy (the standards have not been preserved with exactitude), yet keeps very close to those

that are most important, and improves our most incongruous ones, at the same time that it effects a regular systematization of the whole.

Commencing from a degree of latitude, a broad basis of departure, and working through our measures of length, surface, and capacity, we arrive at the smallest of our present measures of capacity, and institute a new minim differing from the old one by an inappreciable quantity, less than 1 per cent., or in fact a three-thousandth part of a minim. The simplified measures of weight are made to correspond exactly with those of capacity, by adopting a new grain, which is the exact weight of the new minim of distilled water. We thus obtain a sufficiently approximate decimal system both of measures of weight and of capacity, which anyone can learn in an hour, without being troubled by any new names, any very great alterations, or any severe shocks to conservative habits of thought.

First, as regards measures of length and surface. We have already a nautical and geographical mile, which is the nautical mile of all nations, and is the sixtieth part of a degree of latitude; it is a perfect mile, far better than our mistaken statute mile of 5280 feet, and even our old English mile of 5000 feet. Let us assume this mile to be the best possible, and divide it into 6000 new feet, or into 2000 new yards; each of these new feet and new yards will then be greater by only about 1 per cent. than the old (or present) foot and yard; the corresponding new inch and hand of horse-measurement will also vary in the same ratio to the old inch and hand, the new fathom also in the same ratio, a thousand of them forming the mile. The new acre-side will then be exactly 200 new feet, and will be only 3 per cent. smaller than the old one. The new square geographical mile will then (to the exclusion of our statute mile) form 900 new acres. The new square yard, square foot, and square inch

will be only 3 per cent. greater than the corresponding old measures.

Secondly, as regards measures of capacity and of weight which we wish to decimalize, and in which we can make a greater alteration without any harm.

The new cubic foot is 4 per cent. greater than the old one. We divide it into five gallons, each of which is three-tenths larger than the old gallon; the new gallon into ten pints, each of which is only 4 per cent. greater than the old pint, and not enough to disturb the equanimity of anyone; the quart and the quartern being, as hitherto, equal to two pints, and a quarter of a pint respectively, and keeping the same ratio to the old measures, or differing by 4 per cent. The new pint is divided into twenty new fluid-ounces, differing in the same way by 4 per cent. from the old fluid-ounce; the new fluid-ounce is divided into ten fluid-drachms, each new fluid-drachm being less by about two-tenths than the old fluid-drachm, and hence not possible to cause an overdose to result from the adoption of the new measure; the new fluid-drachm is lastly divided into fifty new minims, each of which only varies by three-thousandths from the old minim.

If, in addition, we make a new bushel or firkin, the same for dry and wet goods, equal to ten new gallons, and also equal to two new cubic feet, we have completed a perfect decimal series of measures of capacity, interpolated with others, all of which are sufficiently near to our old measures to answer all purposes.

The new cubic yard and new cubic inch will, of course, fall outside this series, and will, like the new cubic foot, be 4 per cent. greater than the old ones.

The alteration of the gallon, which is the only serious alteration, consists in very little more than making it five quarts instead of four quarts—a most simple and easily com-

prehended proceeding, not liable to cause any difficulty, and one which might easily be enforced by law. There is no doubt that the quart, though remaining practically as large as before, actually becomes a quint or fifth; but there is no absolute necessity for changing its name, although it would be an improvement to do so.

As to the proposed new combined bushel and firkin, it would be useless to attempt to approximate closely to either the old bushel or the old firkin, and it is far preferable to make it exactly two cubic feet or ten gallons, and thus complete the decimal system up to that point. This alteration is one that would admit of being deferred till subsequently, while, on the contrary, that of the gallon would not.

The new measures of weight are mostly made to correspond exactly to the new decimal measures of capacity. The new hundredweight is a new bushel or firkin of distilled water; the new stone is a gallon of water; the pound is a pint; the ounce weight is a fluid-ounce of water; the drachm is a fluid-drachm; and finally, the new grain is the weight of a new minim of distilled water. The sacrifices required in the alteration of the existing anomalous measures of weight, necessary for the application of this most simple and convenient principle, are not so great as might first be imagined. The new ounce is only 4 per cent. heavier than the existing ounce avoirdupois, the new grain is one-tenth lighter than the existing grain troy, and the new drachm is only three-quarters of the old drachm weight; hence none of these new small measures of weight can lead to any overdose through mistake on the part of the apothecaries, while the advantage of doing away with the three sets of measures of weight, troy, apothecaries, and avoirdupois, would be an immense boon to everyone. The new pound will be as much as three-tenths heavier than the old pound avoirdupois; the stone of ten pounds will

bear a similar proportion to the old butcher's stone, besides abolishing all other stones; the new hundredweight of 100 new pounds will be 16 per cent. heavier than the existing hundredweight; and the new ton weight will bear a similar proportion to the existing ton. The new table of weight then becomes thus:—50 grains to one drachm, 10 drachms to one ounce, 20 ounces to one pound, 10 pounds to one stone, 10 stone to one hundredweight, and 20 hundredweight to one ton.

While mentioning tons of weight, it may not be out of place to suggest the abolition of all tons of measurement, and the substitution for them of cubic yards of measurement, which would obviate many difficulties regarding shipping.

Having thus sketched the scheme of improvement and simplification, which is incorporated in the following table, it becomes necessary to offer a few remarks upon it. It will be noticed that the greater part of the proposed new measures of length, surface, and capacity vary only 1, 2, 3, and 4 per cent. from the existing old ones, the new gallon alone being much altered by being made to consist of very nearly five old quarts instead of four; thus proving a successful application of the principles previously laid down. In the smaller measures, both of weight and capacity, which are those used in preparing medicines, the new measures are intentionally kept smaller than the old ones; thus eliminating all risk from the adoption of the new measures. The more serious alterations are few, and all occur in the heavier measures of weight, in the four cases of the pound, stone, hundredweight, and ton, the two former being each increased by rather more than a quarter, the two latter by about an eighth. All the remaining alterations are trifling, so much so that it is a matter of extreme surprise, to those that have examined this system, that so complete and

uniform a rearrangement of weights and measures can have been designed with so small a number of serious alterations, and that these are made to occur at the points best fitted for them, at the end of the series as naturally developed.

7. Standards and Modes of Comparison.

In basing the proposed new measures of weight on those of capacity, and using distilled water as the means of comparison, we are only adopting a mode fully comprehended and recognized, both by all scientific men and the general public; it may, however, be suggested that the distilled water would be more correctly used at its utmost density, which is at a temperature of 68° Fahrenheit, under an atmospheric pressure of 30″ of mercury, and not, as some believe, at a temperature of 62° Fahrenheit. The standards of weight and of measure once accurately and scientifically determined, and made in metal, will then be exactly correct only at a certain temperature; this can of course be properly arranged. While mentioning the thermometrical scale, it may be not out of place to recommend the adoption of an improvement on the existing Fahrenheit scale. If the new scale had its zero at freezing point, and read off 180° at boiling point, the new degrees would be of the same size as before, and the principal advantage of the Centigrade scale would be retained without adopting its disadvantageously large degrees. In addition to this, as extremely high temperatures are now so much more frequently employed in the useful arts than was formerly the case, a larger unit, being the difference between the temperatures of freezing and boiling water, might be advantageously adopted, independently of the modification proposed, which is more suited to the every-day requirements of the ordinary public.

The matter of coinage is entirely beyond the intention

and scope of this pamphlet; but a remark may, however, be permitted. We have an excellent coinage, which has now been imitated and adopted in Germany, a point which we cannot regard as perfect praise, when we learn that at the same time the Germans are meditating the exclusive adoption of the French artificial system of weights and measures, instead of improving and perfecting their own naturally developed system, which corresponds to our own, as well as that of almost every country except France. It is, however, an acknowledgment. Semi-civilized and barbarous nations do not, however, by any means look on our coins with the same favourable impression. Any ordinary Indian of the most humble classes, on seeing a sovereign for the first time, asks what it is, remarking that it is not gold. There is no deceiving him on that point; there is alloy in it, and he is frank enough to declare himself incapable of assigning a definite value to a mixed metal. This immediately forces one to the conclusion that the weight in grains of valuable metal in our mixed metal coinage, as well as the full weight of the coin itself, should certainly be inscribed on each coin, a point that has hitherto been neglected. Some of our coins might then be made to serve as small measures of weight; more especially the bronze coins, which admit of considerable modification in mixed metal without much alteration of value. In particular, a new penny, equal in value to the old one, might be coined, whose weight might be an actual new pennyweight measure, being equal to 25 new grains, differing by 5 per cent. from the old pennyweight, in the right direction, that is less, the new coins being lighter than the very old pence.

In conclusion, however simple and convenient any proposed system of weights and measures may be, and however small the intended changes, there will not be wanting many to object strenuously to any change whatever; the principles

of such obstructives have been analyzed in the first paragraph. On most of these I would urge that this system requires little or no effort from them, no new names to be learnt, and but a very small amount of alteration. There is one rather childish objection to any change in our anomalous measures that seems to require a reply. It takes the form of the questions, What is then to become of the old metal weights and measures of the tradesman? Are all our milestones to be suddenly rooted up at a considerable expense? Who will make the new standards? and so forth. To all this the replies are,—That if we have a clumsy and inconvenient system at present, we cannot fail to derive great advantage from adopting a better one, and hence it will be worth while to incur the unavoidable expense of a change, which would be a comparative trifle to everyone; that the mode of conducting the change should be that productive of the least amount of inconvenience; that the roads might do well even without any milestones at all; and that old metal weights and measures soon become defective from wear, and require renewal; that there are plenty of able scientific men ready to construct the new standards, and plenty of Inspectors of Measures all over the kingdom that know how to establish a new system without causing much difficulty. There are, however, besides such dissentients, a few obstructives that have quite a distinct policy of their own. One of them, a wealthy commercial member of parliament, is believed to have stated not very long ago in the audience of the nation that a certain amount of fraud was an essential part of commerce, and that no one could get on well in trade without it; this, moreover, was given as a reason for not improving our weights and measures. Now, a statement including also an admission of this nature is commendable for its frankness and candour; besides, it gives one the opportunity of a reply, an advantage not conceded

by a more hypocritical policy. In the first place, the simplification of our weights and measures would be a very great advantage to the whole of the trading and commercial classes, as it would save both them and the general public a large amount of care, time, and thought, in the calculations and business of every-day life. Care, time, and thought resolve themselves into time and labour, which can be represented by money. Money will therefore be saved and a profit made by the adoption of simplified weights and measures. In the second place, those that make a business of cheating have such an endless number of opportunities for displaying their powers, adulteration, overcharge, substitution, misstatements, exaggeration, evasion, departures from agreement, intentional mistakes, forgetfulness, intimidation, bounce, &c., in addition to short and long measures; the loss of one of these opportunities is a mere bagatelle to them; while to those having sufficient ability to transact commercial affairs without recourse to such means, no loss could possibly result. Besides, the rising generation is being made to undergo a compulsory education, of which it will soon take so great an advantage, that any simplification of weights and measures will soon be unable to affect either the tradesman or the customer in the above-mentioned respect. Most sensible people, however, will also probably admit that they cannot attach any credence to the sweepingly-broad assertion of the member of parliament referred to, for the reason that it assumes that a shortsighted policy is more profitable than a longsighted one; while they will, on the contrary, believe sincerely in the great advantages to everyone that would result from simplifying our measures, and hope that, should any modification of the system above proposed be considered an advantage, it will be effected on the same natural principles and on the same comprehensive scale.

8. Table of the New proposed System of English Weights and Measures.

			Equivalents in existing Measures.
	Measures of Length.		
1 degree of latitude	= 60 miles, or knots.		
1 mile, or knot	= 1000 fathoms, or 2000 yards		= 1 geographical mile.
	= 6000 feet, or 30 acre-sides		= 1·152 statute miles.
1 acre-side	= 200 feet		= 0·9748 acre-side.
1 fathom	= 2 yards, or 6 feet		= 1·0138 fathoms.
1 yard	= 3 feet		= 1·0138 yards.
1 foot	= 12 inches		= 1·0138 feet.
	Measures of Surface.		
1 square mile	= 900 acres		= 1 sq. geographical mile.
			= 1·3271 sq. statute miles.
1 acre	= 40,000 square feet		= 0·9437 acre.
1 rood	= 10,000 „ „		= 0·9437 rood.
1 square yard	= 9 „ „		= 1·0277 square yards.
1 „ foot	= 144 „ inches		= 1·0277 „ feet.
	Measures of Capacity.		
1 cubic yard	= 27 cubic feet, or 13½ bushels		= 1·0421 cubic yards.
1 bushel, or firkin	= 2 „ „	(1,000,000)	= 1·6234 bushels.
	or 10 gallons		= 1·4430 firkins.
1 cubic foot	= 5 gallons, or 1728 cubic inches		= 1·0421 cubic feet.
1 gallon	= 10 pints	(100,000)	= 1·2987 gallons.
1 quart (or quint)	= 2 „		= 1·0389 quarts.
1 pint	= 20 fluid-ounces	(10,000)	= 1·0389 pints.
1 quartern	= 5 „		= 1·0389 quarterns.
1 fluid-ounce	= 10 fluid-drachms	(500)	= 1·0389 fluid-ounces.
1 fluid-drachm	= 50 minims	(50)	= 0·8311 fluid-drachm.
1 minim		(1)	= 0·9973 minim.
	Measures of Weight.		
1 ton	= 20 hundredweight		= 1·1595 tons.
1 hundredweight	= 10 stone	(1,000,000)	= 1·1595 hundredweight.
1 stone	= 10 pounds	(100,000)	= 0·9276 stone of 14 lbs.
			= 1·2986 „ 10 „
1 pound	= 20 ounces	(10,000)	= 1·2986 pounds avoir.
			= 1·5782 „ troy.
1 ounce	= 10 drachms	(500)	= 1·0401 ounces avoir.
			= 0·9470 „ troy.
1 drachm	= 50 grains	(50)	= 0·7575 drachm troy.
			= 1·6620 „ avoir.
1 pennyweight	= 25 grains	(25)	= 0·9469 pennyweight.
1 grain (weight of 1 minim of water)		(1)	= 0·9090 grain troy.

Comparison of the proposed Measures of Capacity with those of Weight.

(1,000,000)	1 firkin or bushel of water	will weigh exactly	1 hundredweight.
(500,000)	1 cubic foot	„ „	half a hundredweight.
(100,000)	1 gallon	„ „	1 stone.
(10,000)	1 pint	„ „	1 pound.
(500)	1 fluid-ounce	„ „	1 ounce weight.
(50)	1 fluid-drachm	„ „	1 drachm „
(1)	1 minim	„ „	1 grain.

The Principal Alterations, varying more than Five per Cent.

NEW SYSTEM.	OLD SYSTEM.
1 bushel = 10 gallons = 100 pints.	1 bushel = 8 gallons = 64 pints.
1 stone = 10 pounds = 200 ounces.	1 stone = 14 lbs. av. = 204·2 oz. tr.

The double system of measures of weight is thus entirely abolished in favour of a single decimal system, which exactly corresponds to the measures of capacity, while it approximates to many of the principal old measures of weight. The connecting points of the entire system of measures are also defined.

9. The Universality of the Principles proposed, and their Application to the Weights and Measures of most Civilized Nations.

The system of natural development has been shown to have existed generally in the weights and measures of all nations, until the Age of Reason, or Reign of Terror of the French, when an entirely artificial system, based on a single natural unit, was adopted by that nation.

The various measures of length and of surface have been shown to bear a striking amount of resemblance, while the local departures from exactness of standard have evidently been the causes of variation in the more recently developed measures of capacity, which are, or have once been, dependent on the former. The measures of weight, on the contrary, are generally more variable, and have besides been

generally based on artificial considerations, some of them being variations on the Roman pound, itself an arbitrary unit.

The habits of ages have forced on modern nations a series of measures in conformity with those habits, an inch, a foot, a yard, and a mile, an acre, and so forth, which, varying though they are, are still absolute wants and requirements, from which they cannot well suddenly depart. This is illustrated by the fact that up to the present day, in some of the rural districts of France, the people think in *journals* and *arpents* and *livres*, and refer to the notaries to convert these quantities into hectares and kilomètres in legal processes, or suits, where the old measures are ignored.

It is therefore hopeless to expect that any purely artificial system of weights and measures can generally be made to supplant the natural ones under a very considerable lapse of time.

No doubt it would be a great advantage to have any international system of measures, however false or artificial it might be; in order, however, that any such system should be really adopted and comparatively easily made use of by the masses, it must be in conformity to a certain extent with their natural wants, and hence be a development on a natural basis.

That any civilized nation should at the present day adopt the French metrical system to the entire exclusion of their own, would hence appear to be a grievous error.

Before the world can be formed into one vast empire, and reap the advantages of freedom from political wars, each nation must first consolidate itself internally, and thus put an end to civil war and tumult. On the same principle also must proceed the systematization of weights and measures; we must join each other on points of common ground, before merging into universal consolidation.

The defects of the French metrical system have been treated on in a foregoing paragraph. An examination of it would lead one to the impression that some theorist, not having the slightest consideration for the wants of the people, had retired to his study with a measure of length, the mètre, a long yard, and developed a decimal system out of that alone in the recesses of obscurity, and that a highly sentimental nation in a very revolutionary age had adopted it as it came forth without examination. In other words, it may be considered as one of the *sentiments distingués* of the French, not worthy of adoption by the practical English, German, or American nations, and only fit for the countries in which the Napoleonic career of conquest forced it with the French sway on the people.

It seems surprising that the German empire in its resuscitated vigour has not yet determined to work out for itself a simplification of its existing measures on natural principles. Such a mode would probably result in something very similar to the system proposed for the English in the foregoing pages. Let us see how simply it might be done, and with how small an amount of serious alteration.

The Rhine-fuss and the post-meil of Prussia are their two most important and well-known measures of length, which should not be very much altered on any account.

The post-mile consists of 24,000 Rhine-fuss, each of which is 1·0297 English feet; there are 14¾ such miles to a degree of latitude. By altering their post-miles by making them slightly shorter, they can obtain one that will possess the advantage of being fifteen to a degree, or exactly equal to four universal nautical and English geographical miles; they can also still make it equal to 24,000 feet, if they slightly reduce the Rhine-fuss from 1·0297 English feet to 1·0137, a change of only 2 per cent.

In that case the Prussian morgen, which now consists of

25,920 square Rhine-fuss, would be altered to 22,500 square feet; and the morgen-side would be 150 new feet, a convenient round number, not causing too serious an alteration.

Proceeding to measures of capacity, the Prussian anker is the most useful one they have; it is not very far from being a cubic foot. If it were made exactly so in accordance with the new foot, and at the same time were made to take the place of the Prussian scheffel as a dry measure, a decimal series of measures could be based upon it, or at least an approximately decimal series running near some of the other old measures, which would then be convenient as well as simple. The Prussian pound is so near to the English pound, that the new pound proposed in the foregoing system, which is one-fiftieth of a cubic foot of distilled water, could be equally well adopted by the Germans, and perhaps also a series of measures of weights corresponding in the same way to those of capacity in the new system.

Such a mode, which could be easily worked out in detail by a scientific and practical German, would put their system on a common basis with that proposed for the English, without doing such violence to the habits of their people as the adoption of a metrical system would necessarily entail.

If again we sketch a corresponding system applicable to the Austrian empire.

Their mile and foot might, in the first place, be altered to those proposed for Germany, making their measures generally interchangeable with ease. The jochart of Austria has an acre-side of 249 feet English, and is 57,600 square feet Austrian; this might be altered into one having an acre-side of 250 new feet, or 62,500 new square feet; the alteration would be so trifling as not to affect the masses. The two principal Austrian measures of capacity, the eimer for

liquids and the metze for dry articles, are sufficiently nearly equal to make them exactly so in simplifying a system; the side of the cube of one is 1·263, and of the other 1·293 feet English; one is 12·769 English gallons, the other 13·536.

By making the side of the cube of a new measure about 1·2599 new feet, and its contents 12·987 present English gallons, it would be exactly 2 cubic feet of the new feet adopted; and as a combined eimer and metze would be identical with the combined bushel and firkin proposed for the English, a decimal series of measures of capacity could then be based on the new eimer. As for the measures of weight, the existing Austrian pound is so near to the new pound proposed for the English, or weight of the fiftieth of a new cubic foot of distilled water, that the change would be trifling; the rest of the measures of weight could afterwards be arranged and systematized decimally, in accordance with the principles before explained.

The same natural principles might even be adopted in the Russian empire, although their measures are generally very dissimilar to those of Teutonic races. The Russian foot is identical with the English foot, and admits of similar modification; the verst is 3500 feet, 104·18 of them going to one degree of latitude; this might either be changed into a new verst of 4000 or of 3000 new feet, which would then be either the 90th or the 120th of a degree of latitude; while the dessatina might be slightly altered by making its side exactly equal to 350 new lineal feet. In the measures of capacity, the tschetvert, whose side is now 1·947 feet, might be made 2 feet of new measure, or equal to 8 cubic feet exactly; and a new vedro for liquids might be fixed, bearing some convenient proportion to this, though not differing too much from the present vedro; while the

decimal subdivision of the cubic foot might still be made independently of it, if desirable and appropriate. As to the Russian measures of weight, they might be made to correspond throughout their system with the new measures of capacity by means of a comparison with distilled water at its maximum density, in the mode previously proposed for British measures, although the detail of subdivision would have to be carried out in accordance with their local wants and requirements.

While speaking of foreign nations, even though Teutonic and of kin to ourselves, we may perhaps be pardoned in mentioning our Transatlantic cousins of the United States, who speak our own language and use most of our measures, although they have adopted the Spanish dollar as the unit of their currency. They have, like ourselves, shown extreme wisdom in not rushing into the exclusive adoption of the artificial metrical system, and throwing aside the incongruous but practically useful system they took with them to the new country. This is the more remarkable, as their Republican tendencies and requirements naturally urge them towards a new and broad classification, and might well have forced them into the miserable fate of Republican Switzerland, where the nominal adoption of the metrical system has led to an almost hopeless complication of old and new measures, practically varying in every canton. In such a plight, what would it avail to declare that they had adopted the top-loftiest of systems? Far from it. They have shown greater prudence than the British by entirely rejecting our modern innovations, the Imperial gallon and bushel, which are based on an arbitrary unit of weight, instead of one of cubic dimension, and thus proceed on a false principle of development. A more notable fact is that a nation owning such an immense extent of territories, whose boun-

daries often consist of parallels of latitude and meridians of longitude, should not already have entirely adopted the geographical and nautical mile, of sixty to a degree, to the exclusion of the more modern and incongruous English statute mile, as well as its parent, the old London mile of 5000 English feet. The subdivision of the geographical mile into 6000 new feet would then seem to be an inevitable consequence at some later date; and a subsequent remodelling of the whole of their measures on that basis would appear to be the next necessary step. It would appear, however, that some of their leading and scientific men have been bitten with a mania for an entirely new system based on a new notation, and this tendency towards the extreme of the artificial has probably acted as the check to any simplification on the principles of natural development. The error of such a tendency, demonstrated in a preceding paragraph, is perhaps a hopeless one, though the check afforded by it has, in the case of the United States, doubtless proved salutary. At present the simplification of weights and measures throughout the United States of America could not be conducted perhaps on any better principle than that advocated in the preceding pages; while the same new measures that are suitable to England would doubtless be as equally well suited to them as is the progressive modification of our language.

The foregoing sketches of the mode in which the simplification of the weights and measures of England, Germany, Austria, Russia, and the United States, might be conducted, are certainly mere suggestions; but at the same time they indicate the natural method by which the systems of all nations may be made to approach each other, without becoming absolutely identical, and thus attain a facility of inter-transformation with exactitude that is very nearly as

desirable as uniformity, while it does not demand the sacrifice caused by giving any severe shock to the habits of thought of the masses, or by requiring a long period for thorough adoption throughout the various and widely-extended populations.

L. D'A. J.

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